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Ishikawa et al.

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(54) **WIRELESS APPARATUS AND DISTORTION COMPENSATING METHOD**

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H04L 25/49 (2006.01)
H04B 15/00 (2006.01)

(52) **U.S. Cl.**

CPC ***H04B 15/00*** (2013.01)
USPC **375/297**; 375/295; 375/296

(58) **Field of Classification Search**

USPC 375/295–297
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,852,630 A * 12/1998 Langberg et al. 375/219
5,864,710 A * 1/1999 Sands et al. 710/5
6,246,286 B1 * 6/2001 Persson 330/149
6,697,436 B1 * 2/2004 Wright et al. 375/296
6,836,517 B2 12/2004 Nagatani et al.
6,907,085 B2 6/2005 Kubo et al.
6,920,127 B2 * 7/2005 Ozluturk et al. 370/342
6,967,436 B2 * 11/2005 Park 313/504
7,164,738 B2 * 1/2007 Miyamoto et al. 375/346
2006/0188038 A1 * 8/2006 Shako et al. 375/296
2013/0177105 A1 * 7/2013 Gonikberg et al. 375/296

FOREIGN PATENT DOCUMENTS

JP 11-136302 5/1999
JP 2001-189685 7/2001
JP 2001-345718 12/2001
JP 2006-074539 3/2006
JP 2009-272762 11/2009

* cited by examiner

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(57) **ABSTRACT**

A wireless apparatus includes amplifying systems each including a storing unit storing a distortion compensation coefficient for compensation for a nonlinear distortion of one or more transmission signals, a compensator compensating for the nonlinear distortion using the distortion compensation coefficient stored in the storing unit, and an amplifier amplifying the transmission signal after distortion compensation. The wireless apparatus further includes a switch that selects feedback signals corresponding to the transmission signals output from the amplifying systems, a subtractor that derives one or more differences between the feedback signal selected in the switch and the transmission signal, a first calculator that derives a distortion compensation coefficient that restricts the difference derived in the subtractor, and a switch controller that controls a length of time during which the feedback signal is selected in the switch depending on magnitude of distortion of the transmission signal output from the amplifying system.

10 Claims, 10 Drawing Sheets

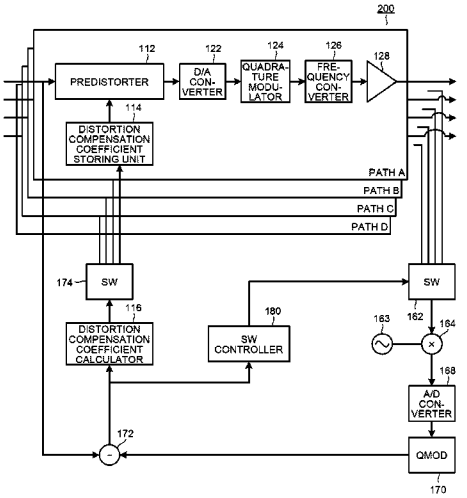


FIG.1

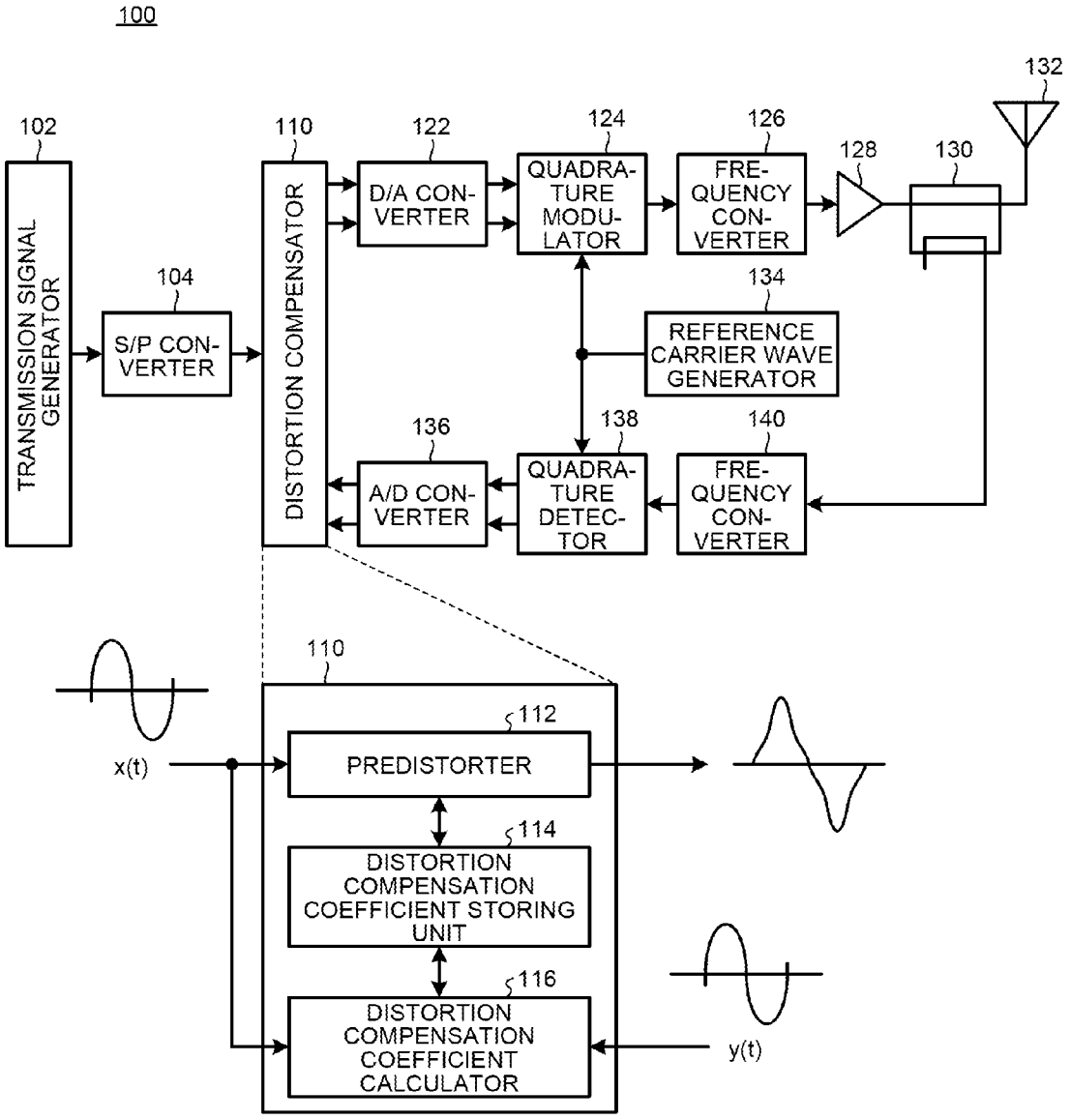

100
102
TRANSMISSION SIGNAL GENERATOR
104
S/P CON-VERTER
110
DISTORTION COMPENSATOR
122
D/A CON-VERTER
124
QUADRA-TURE MODU-LATOR
126
FRE-QUENCY CON-VERTER
128
130
132
134
REFERENCE CARRIER WAVE GENERATOR
136
A/D CON-VERTER
138
QUADRA-TURE DETEC-TOR
140
FRE-QUENCY CON-VERTER
110
112
PREDISTORTER
114
DISTORTION COMPENSATION COEFFICIENT STORING UNIT
116
DISTORTION COMPENSATION COEFFICIENT CALCULATOR
x(t)
y(t)

FIG.2

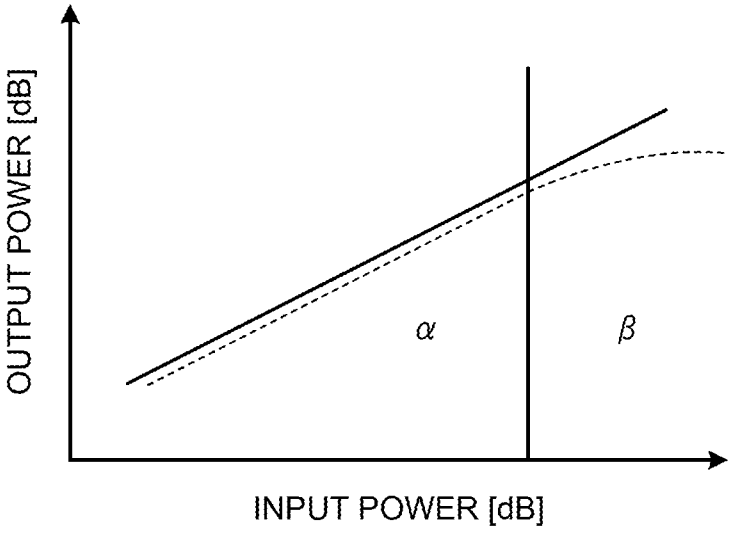


FIG.3

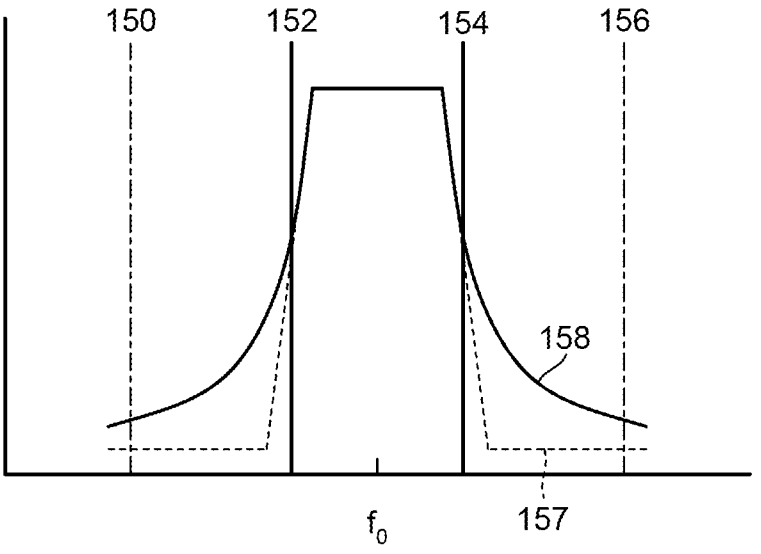


FIG.4

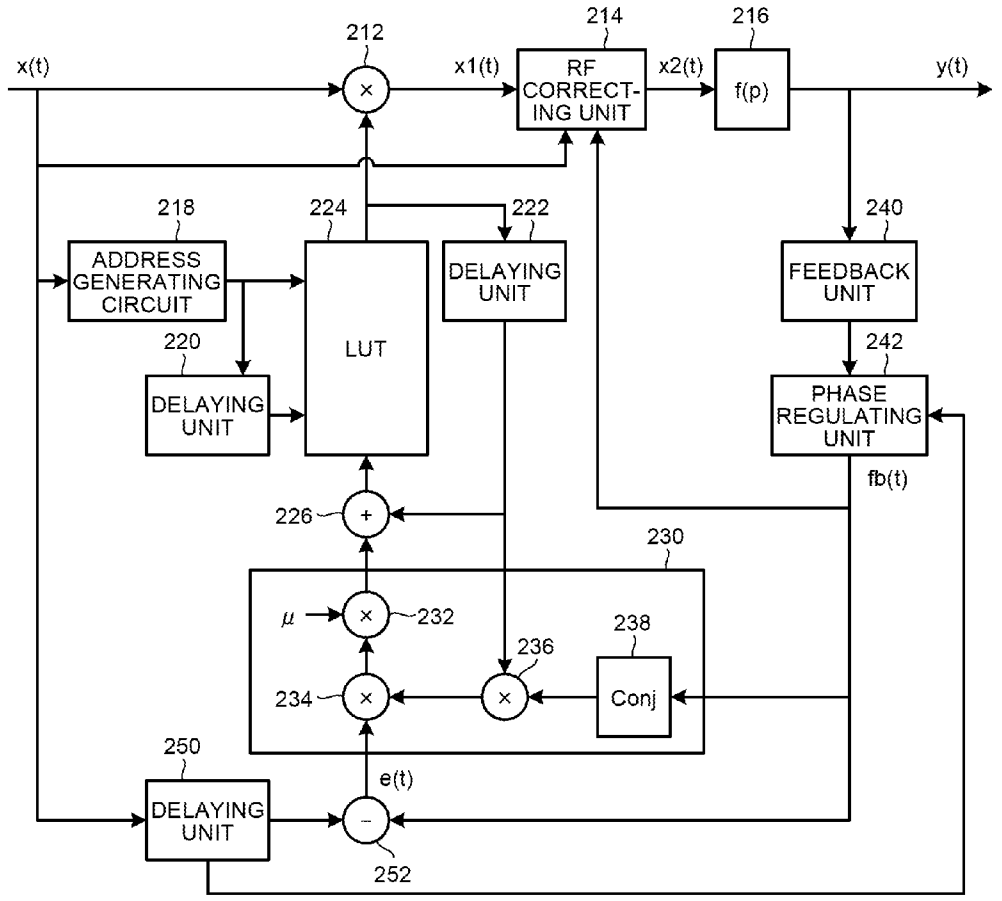

x(t)
212
x1(t)
214
RF CORRECT-ING UNIT
x2(t)
216
f(p)
y(t)
218
ADDRESS GENERATING CIRCUIT
224
222
DELAYING UNIT
240
FEEDBACK UNIT
220
DELAYING UNIT
LUT
242
PHASE REGULATING UNIT
fb(t)
226
230
μ
232
238
236
234
Conj
250
DELAYING UNIT
e(t)
252

FIG.5

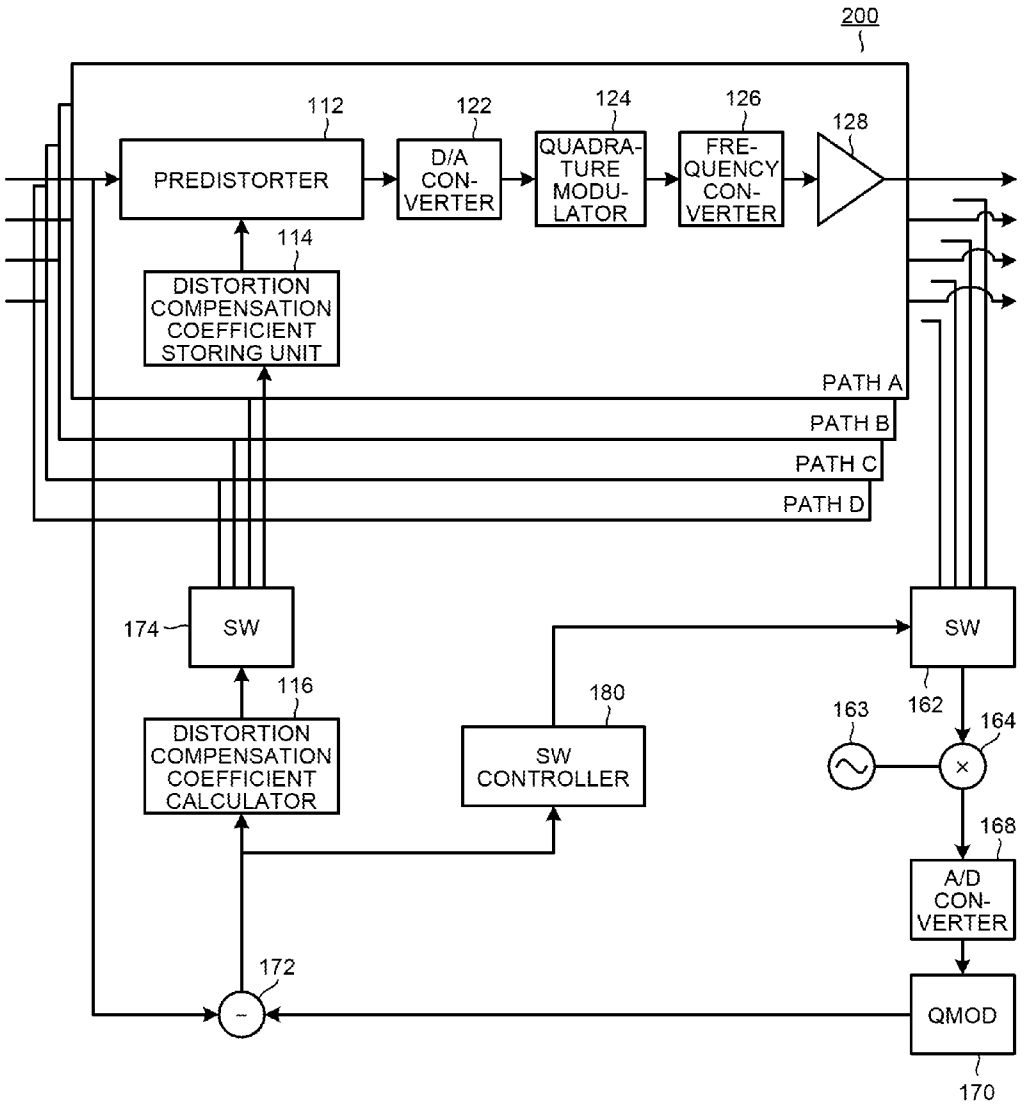

200
112
PREDISTORTER
122
D/A CON-VERTER
124
QUADRA-TURE MODU-LATOR
126
FRE-QUENCY CON-VERTER
128
114
DISTORTION COMPENSATION COEFFICIENT STORING UNIT
PATH A
PATH B
PATH C
PATH D
174
SW
116
DISTORTION COMPENSATION COEFFICIENT CALCULATOR
180
SW CONTROLLER
SW
162
163
164
168
A/D CON-VERTER
QMOD
170
172

FIG.6

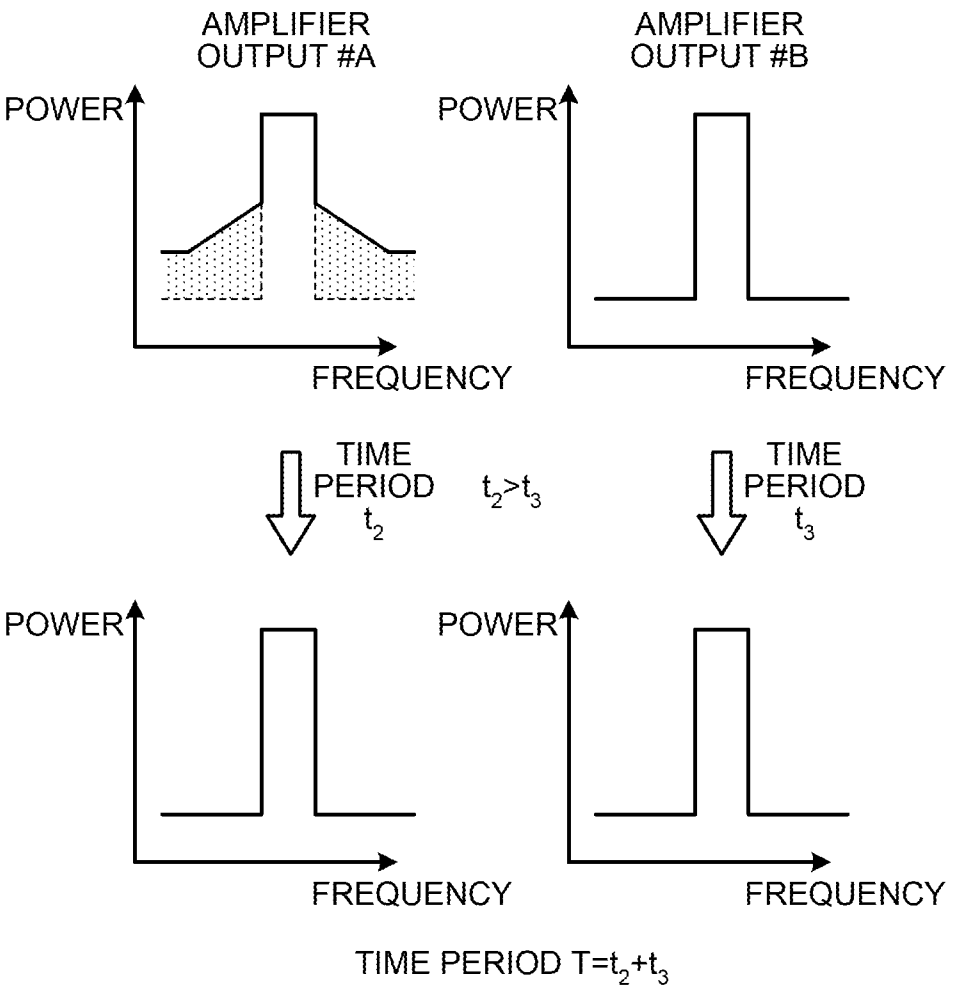

AMPLIFIER OUTPUT #A
AMPLIFIER OUTPUT #B
POWER
FREQUENCY
TIME PERIOD t_2
$t_2>t_3$
TIME PERIOD t_3
TIME PERIOD $T=t_2+t_3$

FIG.7

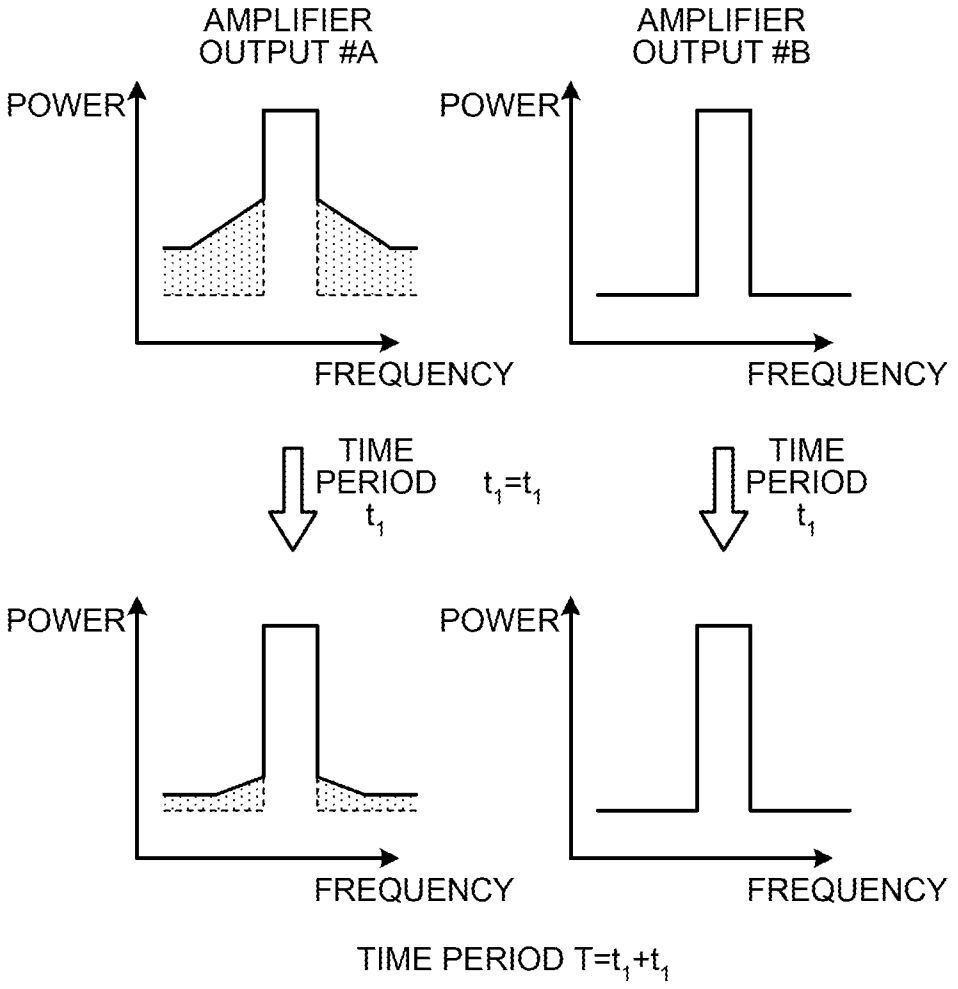

AMPLIFIER OUTPUT #A
AMPLIFIER OUTPUT #B
POWER
FREQUENCY
TIME PERIOD t_1
$t_1=t_1$
TIME PERIOD t_1
TIME PERIOD $T=t_1+t_1$

FIG.8

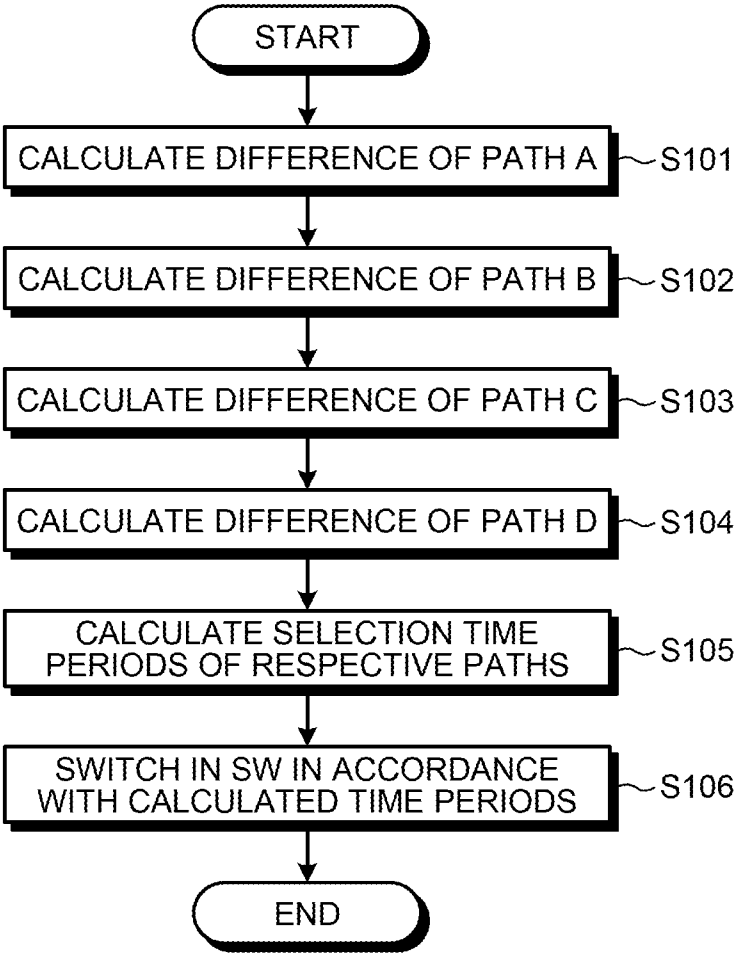

START
CALCULATE DIFFERENCE OF PATH A
S101
CALCULATE DIFFERENCE OF PATH B
S102
CALCULATE DIFFERENCE OF PATH C
S103
CALCULATE DIFFERENCE OF PATH D
S104
CALCULATE SELECTION TIME PERIODS OF RESPECTIVE PATHS
S105
SWITCH IN SW IN ACCORDANCE WITH CALCULATED TIME PERIODS
S106
END

FIG.9

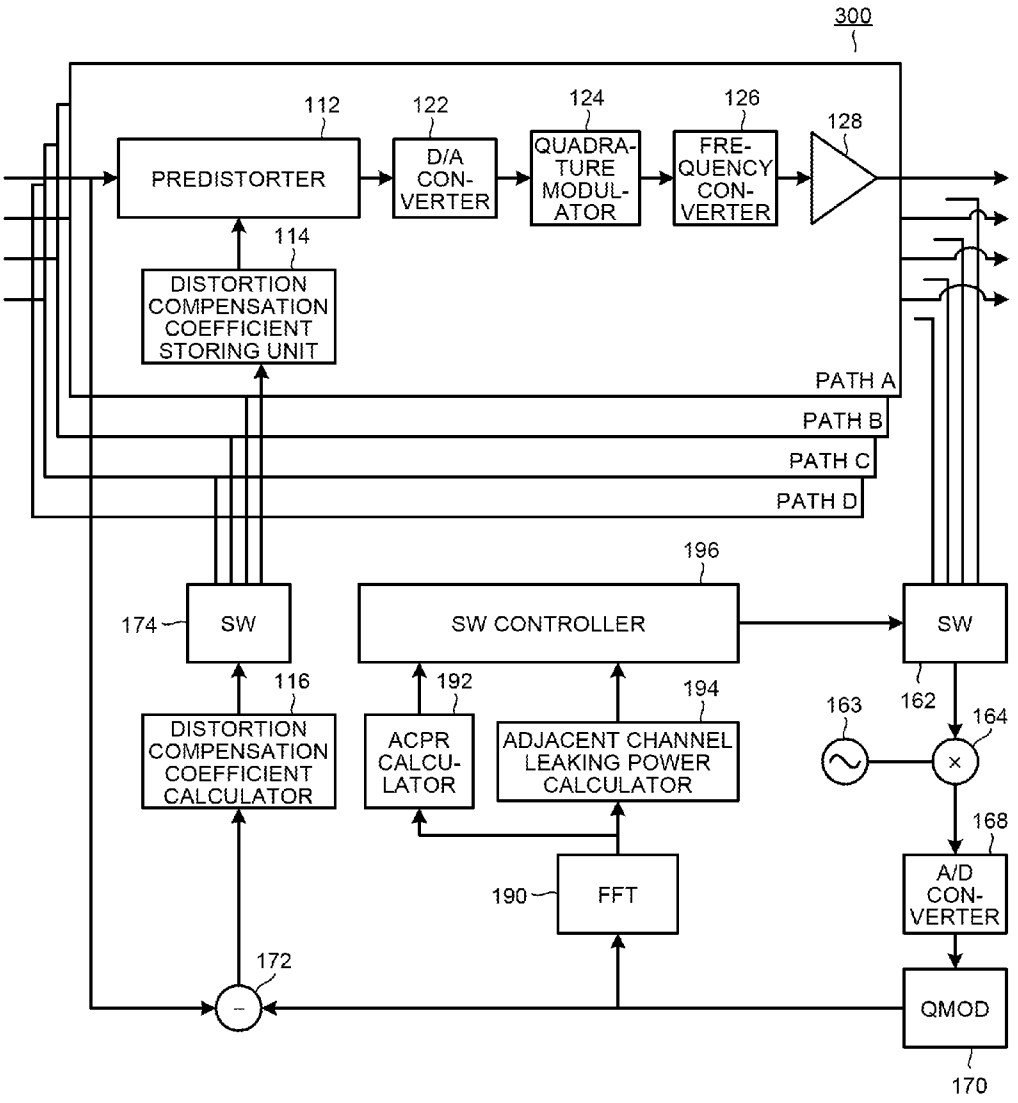

300
112
122
124
126
128
PREDISTORTER
D/A CON-VERTER
QUADRA-TURE MODUL-ATOR
FRE-QUENCY CON-VERTER
114
DISTORTION COMPENSATION COEFFICIENT STORING UNIT
PATH A
PATH B
PATH C
PATH D
196
174
SW
SW CONTROLLER
SW
116
192
194
163
162
164
DISTORTION COMPENSATION COEFFICIENT CALCULATOR
ACPR CALCU-LATOR
ADJACENT CHANNEL LEAKING POWER CALCULATOR
168
190
FFT
A/D CON-VERTER
172
QMOD
170

FIG.10

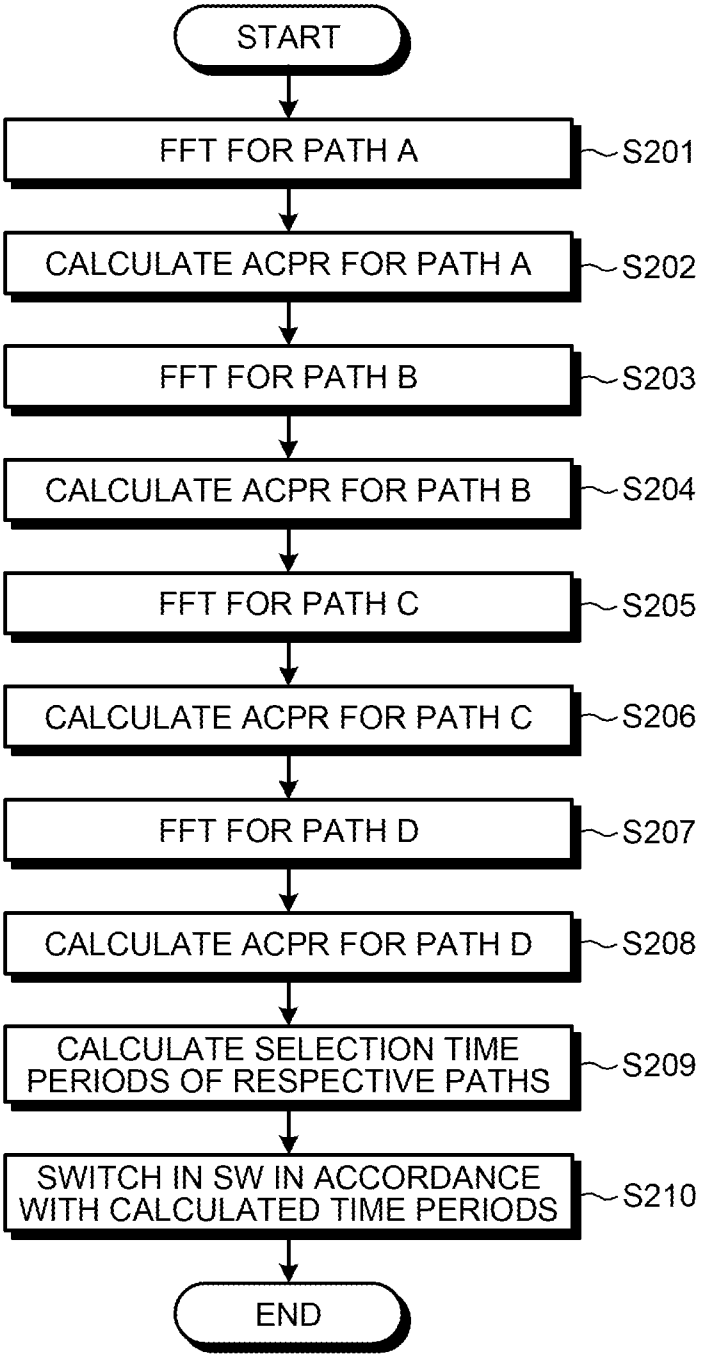
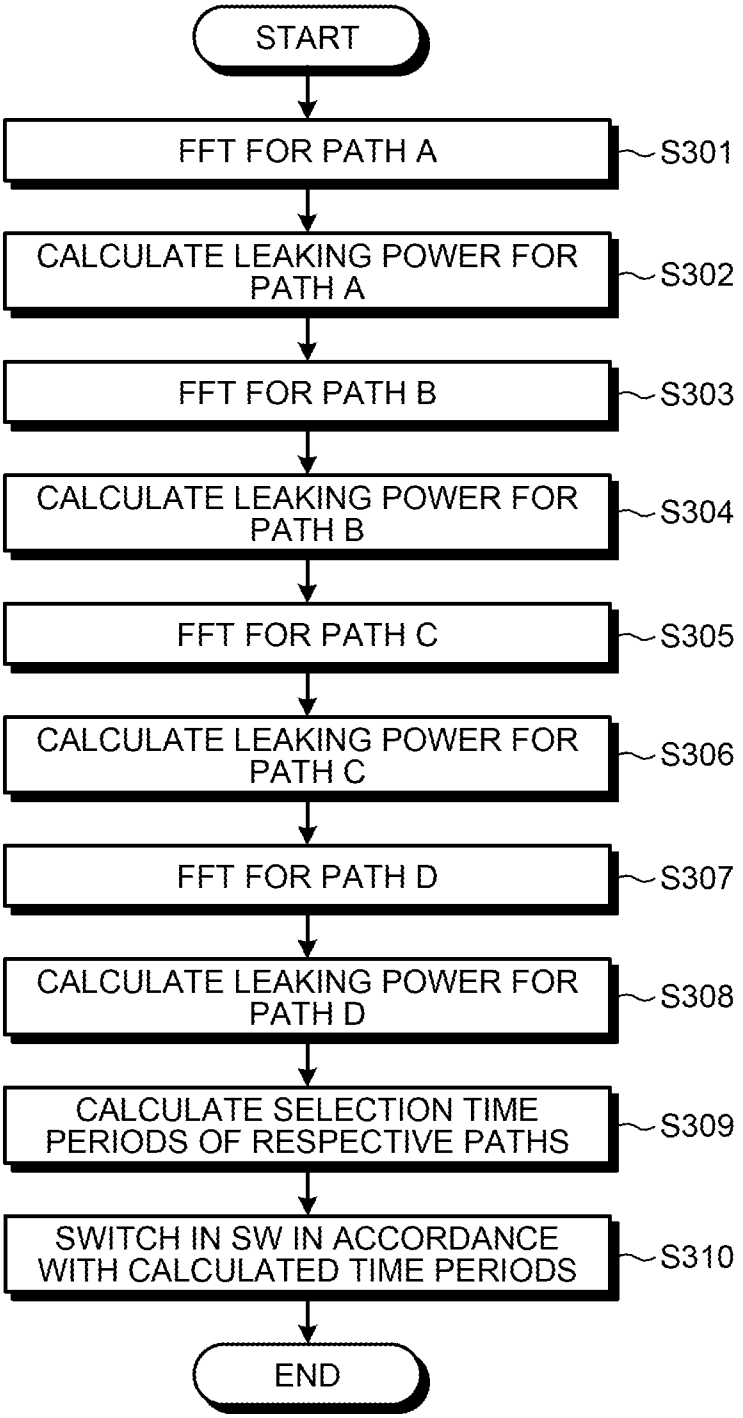

START
FFT FOR PATH A
S201
CALCULATE ACPR FOR PATH A
S202
FFT FOR PATH B
S203
CALCULATE ACPR FOR PATH B
S204
FFT FOR PATH C
S205
CALCULATE ACPR FOR PATH C
S206
FFT FOR PATH D
S207
CALCULATE ACPR FOR PATH D
S208
CALCULATE SELECTION TIME PERIODS OF RESPECTIVE PATHS
S209
SWITCH IN SW IN ACCORDANCE WITH CALCULATED TIME PERIODS
S210
END

FIG.11


START
FFT FOR PATH A
S301
CALCULATE LEAKING POWER FOR PATH A
S302
FFT FOR PATH B
S303
CALCULATE LEAKING POWER FOR PATH B
S304
FFT FOR PATH C
S305
CALCULATE LEAKING POWER FOR PATH C
S306
FFT FOR PATH D
S307
CALCULATE LEAKING POWER FOR PATH D
S308
CALCULATE SELECTION TIME PERIODS OF RESPECTIVE PATHS
S309
SWITCH IN SW IN ACCORDANCE WITH CALCULATED TIME PERIODS
S310
END

WIRELESS APPARATUS AND DISTORTION COMPENSATING METHOD

CROSS-REFERENCE TO RELATED APPLICATION(S)

This application is based upon and claims the benefit of priority of the prior Japanese Patent Application No. 2012-083170, filed on Mar. 30, 2012, the entire contents of which are incorporated herein by reference.

FIELD

The embodiments discussed herein are directed to a wireless apparatus and a distortion compensating method.

BACKGROUND

In recent years, a wireless apparatus such as a mobile phone and a smartphone comes to have a digital communication function, and data transmission is performed with high efficiency. When a wireless apparatus which sends data employs a multi-phase modulation system for data transmission, preferably an amplification characteristic of a transmission power amplifier is linearized to suppress a nonlinear distortion and to reduce leakage power to adjacent channels.

When an amplifier with low linearity is employed in an effort to improve power efficiency, it is preferable that a nonlinear distortion that occurs due to the low linearity be compensated. To this end, wireless apparatuses are provided with a distortion compensator that compensates for the nonlinear distortion of the power amplifier.

For example, a transmission signal is converted into two signals, i.e., an I signal and a Q signal, by an S/P (Serial/Parallel) converter. Then, the I signal and the Q signal are subjected to amplification processing. Thereafter, a part of the amplified signal is fed back as a feedback signal. The distortion compensator compares the I signal and the Q signal with the feedback signals, and calculates a distortion compensation coefficient so that a difference between the I signal/Q signal and the feedback signal is zero. Then, the distortion compensator performs distortion compensation by multiplying the I signal and Q signal, i.e., the converted transmission signal, with the distortion compensation coefficient. The distortion compensator compares the transmission signal before the distortion compensation with a feedback signal obtained by extracting a part of a signal amplified after the distortion compensation, and sequentially updates the distortion compensation coefficient so that the difference between these signals is zero. As to an example of such a conventional technique, see Japanese Laid-open Patent Publication No. 2001-189685, for example.

However, the conventional technique does not consider reducing a time taken for compensating the distortion of signals output from a plurality of amplifiers.

A wireless apparatus including a plurality of amplifiers may update the distortion compensation coefficient for each amplifier by switching between feedback signals from the amplifiers equally in a time-divisional manner, and comparing each feedback signal with a corresponding transmission signal.

Depending on the states of distortion in output signals from the plurality of amplifiers, a time taken for distortion compensation of the output signals can be long. For example, assume that distortion compensation is performed for two amplifiers; and an output signal from one amplifier experiences a relatively large distortion while an output signal from the other amplifier experiences no distortion. In this case, if the distortion compensation coefficients for the two amplifiers are updated equally in a time-divisional manner, an assigned time slot is not long enough for the signal experiencing a relatively large distortion for updating the distortion compensation coefficient, and hence, the update will be insufficient. On the other hand, the distortion compensation coefficient of the signal not experiencing a distortion is also updated, which is unnecessary. Consequently, as to the amplifiers as a whole, a time taken for the distortion compensation of the output signals may become long, because the distortion compensation of the output signal from the amplifier which experiences a relatively large distortion may take a long time until it finishes.

SUMMARY

According to an aspect of an embodiment, a wireless apparatus includes a plurality of amplifying systems. Each of the amplifying systems includes a storing unit that stores a distortion compensation coefficient for use in compensation for a nonlinear distortion of one or more transmission signals, a compensator that compensates for the nonlinear distortion of the transmission signal with use of the distortion compensation coefficient stored in the storing unit, and an amplifier that amplifies the transmission signal subjected to distortion compensation in the compensator. The wireless apparatus further includes a switch that selects a plurality of feedback signals corresponding to the plurality of transmission signals output from the plurality of amplifying systems sequentially in a time-divisional manner, a subtractor that derives one or more differences between the feedback signal selected in the switch and the transmission signal, corresponding to the feedback signal, before distortion compensation in the compensator, a first calculator that derives a distortion compensation coefficient that restricts the difference derived in the subtractor and updates the distortion compensation coefficient stored in the storing unit in the corresponding amplifying system by the derived distortion compensation coefficient, and a switch controller that controls a length of time during which each of the feedback signals is selected in a time-divisional manner in the switch depending on magnitude of a distortion of each of the plurality of transmission signals output from the plurality of amplifying systems.

According to another aspect of an embodiment, a distortion compensating method includes (a) executing in each of a plurality of amplifying systems, (a1) reading a distortion compensation coefficient from a storing unit that stores the distortion compensation coefficient for use in compensation for a nonlinear distortion of one or more transmission signals and compensating for the nonlinear distortion of the transmission signal with use of the read distortion compensation coefficient, and (a2) amplifying the transmission signal subjected to distortion compensation, (b) selecting a plurality of feedback signals corresponding to the plurality of transmission signals output from the plurality of amplifying systems sequentially in a time-divisional manner, (c) deriving a difference between the selected feedback signal and the transmission signal, corresponding to the feedback signal, before the distortion compensation, (d) deriving a distortion compensation coefficient that restricts the derived difference and updating a storing unit in the corresponding amplifying system by the derived distortion compensation coefficient, and (e) controlling a length of time during which each of the feedback signals is selected in a time-divisional manner

depending on magnitude of a distortion of each of the plurality of transmission signals output from the plurality of amplifying systems.

The object and advantages of the invention will be realized and attained by means of the elements and combinations particularly pointed out in the claims.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are not restrictive of the invention, as claimed.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** illustrates an exemplary configuration of a wireless apparatus according to a first embodiment;

FIG. **2** illustrates an input/output characteristic of an amplifier;

FIG. **3** describes a nonlinear distortion generated by a nonlinear characteristic;

FIG. **4** illustrates an exemplary configuration of a distortion compensator;

FIG. **5** illustrates an exemplary configuration of a wireless apparatus according to a second embodiment;

FIG. **6** illustrates an example of update time periods in an LUT;

FIG. **7** illustrates a comparative example of update time periods in the LUT;

FIG. **8** illustrates a flowchart of an exemplary process performed by the wireless apparatus according to the second embodiment;

FIG. **9** illustrates an exemplary configuration of a wireless apparatus according to a third embodiment;

FIG. **10** illustrates a flowchart of an exemplary process performed by the wireless apparatus according to the third embodiment; and

FIG. **11** illustrates a flowchart of another exemplary process performed by the wireless apparatus according to the third embodiment.

DESCRIPTION OF EMBODIMENTS

Preferred embodiments of the present invention will be explained with reference to accompanying drawings. It is to be noted that a disclosed technique is not limited by these embodiments.

[a] First Embodiment

FIG. **1** illustrates a configuration of a wireless apparatus according to a first embodiment. As illustrated in FIG. **1**, a wireless apparatus **100** includes a transmission signal generator **102**, a serial/parallel converter (S/P converter) **104**, a distortion compensator **110**, and a D (Digital)/A (Analog) converter **122**. The wireless apparatus **100** also includes a quadrature modulator **124**, a frequency converter **126**, an amplifier **128**, a directional coupler **130**, an antenna **132**, and a reference carrier wave generator **134**. The wireless apparatus **100** further includes an A/D converter **136**, a quadrature detector **138**, and a frequency converter **140**. The distortion compensator **110** includes a predistorter **112**, a distortion compensation coefficient storing unit **114**, and a distortion compensation coefficient calculator **116**. The distortion compensator **110** is achieved, e.g., by a DSP (Digital Signal Processor).

The transmission signal generator **102** generates a serial digital data string to be transmitted from the wireless apparatus **100**. The serial/parallel converter **104** divides the digital data string generated in the transmission signal generator **102** alternately on a bit-by-bit basis and converts it into 2 signals, i.e., an in-phase component signal (I signal) and a quadrature component signal (Q signal).

The D/A converter **122** converts each of the I signal and the Q signal into an analog baseband signal. The quadrature modulator **124** performs a quadrature modulation by multiplying the I signal and the Q signal (transmission baseband signals) output from the D/A converter **122** by a reference carrier wave generated in the reference carrier wave generator **134** and a carrier wave having a phase shifted by 90 degrees from the phase of the reference carrier wave, respectively, and adding the multiplication results.

The frequency converter **126** mixes the quadrature signal output from the quadrature modulator **124** with a local oscillation signal and converts the frequency of the mixed signal into a radio frequency. The amplifier **128** amplifies the radio frequency signal output from the frequency converter **126** and radiates the signal in the air through the directional coupler **130** and the antenna **132**.

The directional coupler **130** feeds a part of the transmission signal back to the frequency converter **140** and inputs the signal in the frequency converter **140**. The frequency converter **140** converts the frequency of the feedback signal. The quadrature detector **138** performs a quadrature detection by multiplying the feedback signal output from the frequency converter **140** by the reference carrier wave generated in the reference carrier wave generator **134** and the signal having a phase shifted by 90 degrees from the phase of the reference carrier wave to reproduce the I signal and the Q signal as the baseband signals on the transmission side. The A/D converter **136** converts the feedback signals output from the quadrature detector **138** into digital signals and inputs the digital signals in the distortion compensator **110**.

The distortion compensation coefficient storing unit **114** stores distortion compensation coefficients h(pi) corresponding to power values pi (i=0 to 1023) of a transmission signal x(t). The predistorter **112** performs distortion compensation processing (predistortion) on the transmission signal with the use of a distortion compensation coefficient h(pi) corresponding to a power level of the transmission signal. The distortion compensation coefficient calculator **116** compares the transmission signal x(t) with a demodulated signal (feedback signal) y(t) demodulated in the quadrature detector **138**, calculates a distortion compensation coefficient h(pi) so that a difference between these signals is zero, and updates the distortion compensation coefficient stored in the distortion compensation coefficient storing unit **114**.

In this manner, the distortion compensator **110** updates the distortion compensation coefficient in an adaptive manner so that a difference between the feedback signal which is a part of the signal amplified in the amplifier **128** and the transmission signal before distortion compensation is zero.

Next, an input/output characteristic of the amplifier and a nonlinear distortion generated by a nonlinear characteristic will be described. FIG. **2** illustrates an input/output characteristic of the transmission power amplifier. FIG. **3** describes a nonlinear distortion generated by a nonlinear characteristic.

For example, in mobile communication such as W-CDMA (Wideband Code Division Multiple Access), transmission power of the wireless apparatus is as large as 10 mW to tens of W, and an input/output characteristic (which has a distortion function f(p)) of the amplifier **128** has a nonlinear characteristic as illustrated by a dotted line in FIG. **2**. A nonlinear distortion is generated by this nonlinear characteristic, and as for a spectrum of frequencies around a transmission frequency f_0, the side lobes rise from a characteristic illustrated

by a dashed line **157** to a characteristic illustrated by a solid line **158** in FIG. **3**. Thus, the transmission signal leaks to adjacent channels, which causes an adjacent channel interference. That is, due to the nonlinear distortion illustrated in FIG. **2**, power of the transmission signal leaking to the adjacent frequency channels becomes large as illustrated in FIG. **3**.

An ACPR (Adjacent Channel Power Ratio) indicates the magnitude of leaking power. In FIG. **3**, ACPR is a ratio between adjacent leaking power leaking to adjacent channels represented by a spectrum area between a frequency band **150** and a frequency band **156** to power of a channel of interest represented by a spectrum area between a frequency band **152** and a frequency band **154**. Such leaking power is strictly regulated since it becomes noise for the other channels and degrades a communication quality of the channels.

The amount of leaking power is small in a linear region (linear region α in FIG. **2**) of the power amplifier and is large in a nonlinear region β, for example. Thus, in a high-power transmission power amplifier, it is preferable to increase the linear region α. However, in order to increase the linear region, the amplifier needs to exhibit higher performance than actually wanted performance. This may be a disadvantage in terms of cost and size of the apparatus. Under such circumstances, the distortion compensator **110**, which compensates for a distortion of transmission power, is provided in the wireless apparatus **100**.

Next, an exemplary configuration of the distortion compensator **110** will be described. FIG. **4** illustrates an exemplary configuration of the distortion compensator **110**. As illustrated in FIG. **4**, the distortion compensator **110** includes a multiplier **212**, an RF correcting unit **214**, a distortion function calculator **216**, an address generating circuit **218**, delaying units **220** and **222**, an LUT (Look Up Table) **224**, and an adder **226**. The distortion compensator **110** also includes a distortion compensation coefficient calculator **230**, a feedback unit **240**, a phase regulating unit **242**, a delaying unit **250**, and a subtractor **252**. The distortion compensation coefficient calculator **230** includes multipliers **232**, **234**, and **236** and a conjugate complex signal outputting unit **238**.

The multiplier **212** in FIG. **4** corresponds to the predistorter **112** in FIG. **1**. The multiplier **212** multiplies a transmission signal x(t) by a distortion compensation coefficient hn−1(p). The distortion function calculator **216** in FIG. **4** corresponds to the amplifier **128** in FIG. **1**.

Also, the feedback unit **240** in FIG. **4** corresponds to a part including the directional coupler **130**, the frequency converter **140**, the quadrature detector **138**, and the A/D converter **136** in FIG. **1**. The LUT **224** in FIG. **4** corresponds to the distortion compensation coefficient storing unit **114** in FIG. **1**. The distortion compensation coefficient calculator **230** in FIG. **4** corresponds to the distortion compensation coefficient calculator **116** in FIG. **1**.

In FIG. **4**, the LUT **224** stores distortion compensation coefficients that cancel distortions of the distortion function calculator **216** (amplifier) in two-dimensional address locations corresponding to respective discrete power values of a transmission signal x(t). When a transmission signal x(t) is input, the address generating circuit **218** calculates a power value p (=x2(t)) of the transmission signal x(t) and generates an address in a one-dimensional direction such as an X-axial direction address uniquely corresponding to the calculated power value p (=x2(t)) of the transmission signal x(t). At the same time, the address generating circuit **218** derives a difference ΔP from a power value **p1** (=x2(t−1)) of a transmission signal x(t−1) at a previous time point (t−1) stored in the address generating circuit **218** and generates an address in another-dimensional direction such as a Y-axial direction address uniquely corresponding to the calculated difference ΔP.

The distortion compensator **110** outputs a storage location of the LUT **224** specified by the X-axial direction address P and the Y-axial direction address ΔP generated in the address generating circuit **218** as specifying information of a readout address (AR). Subsequently, a distortion compensation coefficient hn−1(p) stored in this readout address is read out from the LUT **224** and is used for distortion compensation processing in the multiplier **212**. The RF correcting unit **214** performs processing such as frequency conversion processing of a distortion-compensated signal based on a signal after the distortion compensation in the multiplier **212**, a signal without distortion compensation, and a signal subjected to phase regulation in the phase regulating unit **242**.

An update value for update of a distortion compensation coefficient stored in the LUT **224** is calculated in the distortion compensation coefficient calculator **230**. Specifically, the distortion compensation coefficient calculator **230** is configured to include the conjugate complex signal outputting unit **238** and the multipliers **232**, **234**, and **236**. The subtractor **252** outputs a difference e(t) between the transmission signal x(t) delayed in the delaying unit **250** and a demodulated feedback signal y(t) (feedback signal).

The multiplier **236** multiplies the distortion compensation coefficient hn−1(p) by y*(t) and obtains an output u*(t) (=hn−1(p)y*(t)). The multiplier **234** multiplies the difference output e(t) of the subtractor **252** by u*(t). The multiplier **232** multiplies a step size parameter μ by an output of the multiplier **234**.

Subsequently, the adder **226** adds the distortion compensation coefficient hn−1(p) to an output μe(t)u*(t) of the multiplier **232** to obtain an update value of the LUT **224**. The update value is stored in a writing address (AW) specified by the X-axial direction address and the Y-axial direction address as an address uniquely corresponding to the power value p (=x2(t)) of the transmission signal generated in the address generating circuit **218**.

Meanwhile, the readout address (AR) described above and the writing address (AW) are the same address. However, since it takes calculating time and the like until the update value is obtained, the readout address is delayed in the delaying unit **220** and is used as the writing address.

The delaying units **220**, **222**, and **250** add delay time D from the input of the transmission signal x(t) to the input of the demodulated feedback signal y(t) in the subtractor **252** to the transmission signal. The delay time D set in the delaying units **220**, **222**, and **250** is determined so that D=D**0**+D**1** may be satisfied where D**0** is delay time in the distortion function calculator **216** (amplifier), and D**1** is delay time in the feedback unit **240**.

By the above configuration, the following calculations are performed.

$$hn(p)=hn-1(p)+\mu e(t)u^*(t)$$

$$e(t)=x(t)-y(t)$$

$$y(t)=hn-1(p)x(t)f(p)$$

$$u^*(t)=x(t)f(p)=hn-1(p)y^*(t)$$

$$p=|x(t)|2$$

In the above equations, x, y, f, h, u, and e are complex numbers, and * is a conjugate complex number. By the above calculation processing, the distortion compensation coefficient h(p) is updated so that the difference signal e(t) between

the transmission signal x(t) and the demodulated feedback signal y(t) may be minimum and results in an optimal distortion compensation coefficient value, and the distortion of the amplifier **128** is compensated.

[b] Second Embodiment

The wireless apparatus according to the first embodiment may include a plurality of amplifying systems (paths) each including the predistorter **112**, the D/A converter **122**, the quadrature modulator **124**, the frequency converter **126**, the amplifier **128**, and the like. Description in this respect will be provided as a second embodiment. FIG. **5** illustrates an exemplary configuration of a wireless apparatus according to the second embodiment.

As illustrated in FIG. **5**, the wireless apparatus **200** includes a plurality of amplifying systems (a path A, a path B, a path C, and a path D). Since the path A, the path B, the path C, and the path D are similarly configured, the path A will be described as a representative.

The path A includes the predistorter **112**, the distortion compensation coefficient storing unit **114**, the D/A converter **122**, the quadrature modulator **124**, the frequency converter **126**, and the amplifier **128**. Since the respective configurations of these components have been described with respect to FIG. **1**, duplicate description is not provided.

The wireless apparatus **200** includes a switch (SW) **162**, a reference carrier wave generator **163**, a multiplier **164**, an A/D converter **168**, a modulator (QMOD) **170**, a subtractor **172**, the distortion compensation coefficient calculator **116**, a switch (SW) **174**, and an SW controller **180**. The paths A to D have in common the switch (SW) **162**, the reference carrier wave generator **163**, the multiplier **164**, the A/D converter **168**, the modulator (QMOD) **170**, the subtractor **172**, the distortion compensation coefficient calculator **116**, the switch (SW) **174**, and the SW controller **180**.

The switch **162** selects feedback signals as parts of signals output from the paths A to D sequentially in a time-divisional manner. The multiplier **164** multiplies a reference carrier wave output from the reference carrier wave generator **163** by a feedback signal selected in the switch **162**. The subtractor **172** derives a difference between the feedback signal output from the multiplier **164** and undergoing A/D conversion processing and modulation processing and a transmission signal, corresponding to this feedback signal, before distortion compensation in the predistorter **112**. The distortion compensation coefficient calculator **116** derives a distortion compensation coefficient that restricts the difference derived in the subtractor **172** and updates a distortion compensation coefficient stored in the distortion compensation coefficient storing unit **114** in a corresponding path by the derived distortion compensation coefficient. Specifically, the switch **174** stores the distortion compensation coefficient output from the distortion compensation coefficient calculator **116** in the distortion compensation coefficient storing unit **114** in a corresponding path among the paths A to D to update the distortion compensation coefficient.

In this manner, by providing the switch **162** and the switch **174**, the plurality of paths A to D may have the reference carrier wave generator **163**, the multiplier **164**, the A/D converter **168**, the modulator (QMOD) **170**, the subtractor **172**, the distortion compensation coefficient calculator **116**, and the like in common.

The SW controller **180** controls the length of time during which each feedback signal is selected in a time-divisional manner in the switch **162** depending on the magnitude of a distortion of each of the plurality of transmission signals output from the plurality of paths A to D. For example, the SW controller **180** controls the length of time during which each feedback signal is selected in a time-divisional manner in the switch **162** depending on the magnitude of the difference derived in the subtractor **172**. More specifically, the SW controller **180** compares a plurality of differences corresponding to the plurality of feedback signals derived in the subtractor **172** with one another and makes the length of time (referring time of a feedback signal) during which the feedback signal is selected in a time-divisional manner in the switch **162** longer for a feedback signal from an amplifying system having a larger difference. In other words, the SW controller **180** provides an amplifying system having a larger difference with a larger number of times of updating of the distortion compensation coefficient stored in the distortion compensation coefficient storing unit **114** (LUT).

Control in the SW controller **180** will be described further in details. FIG. **6** illustrates an example of update time periods in the LUT. In FIG. **6**, an example with two paths A and B is illustrated for simplicity of description. As illustrated in frequency spectra at the upper portion of FIG. **6**, it is assumed that a signal output from an amplifier of the path A has a relatively large distortion (side lobes rise) and that a signal output from an amplifier of the path B experiences almost no distortion (side lobes do not rise).

In this case, the SW controller **180** compares a difference of the path A output from the subtractor **172** with a difference of the path B and determines that the signal output from the amplifier of the path A has a larger distortion than the signal output from the amplifier of the path B. The SW controller **180** then sets time period t_2 during which the signal output from the amplifier of the path A is selected in the switch **162** to be longer than time period t_3 during which the signal output from the amplifier of the path B is selected ($t_2 > t_3$). The sum of t_2 and t_3 is time period T of 1 cycle for sequentially selecting the signal of the path A and the signal of the path B.

By controlling the selection time periods in a manner of $t_2 > t_3$, update of the distortion compensation coefficient is performed frequently for the signal of the path A, which experiences a relatively large distortion, and consequently, sufficient distortion compensation is performed (the rise of the side lobes is significantly decreased) as illustrated in a frequency spectrum at the lower portion of FIG. **6**. On the other hand, update of the distortion compensation coefficient is not performed so frequently for the signal of the path B, which experiences almost no distortion, but since there is nearly no distortion from the beginning, the rise of the side lobes does not occur.

A comparative example of update in the LUT in a case where the SW controller **180** is not provided will be described. FIG. **7** illustrates a comparative example of update time periods in the LUT. In FIG. **7**, two paths A and B are illustrated, similarly to FIG. **6**, for the simplicity of description. As illustrated in frequency spectra at the upper portion of FIG. **7**, it is assumed that a signal output from an amplifier of the path A has a relatively large distortion (side lobes rise) and that a signal output from an amplifier of the path B experiences almost no distortion (side lobes do not rise).

In the comparative example, the switch **162** selects the signal output from the amplifier of the path A and the signal output from the amplifier of the path B equally in a time-divisional manner. That is, in the comparative example, each of a time period during which the signal output from the amplifier of the path A is selected in the switch **162** and a time period during which the signal output from the amplifier of the path B is selected in the switch **162** is set to time period t_1.

The sum of t_1 and t_1 is time period T of 1 cycle for sequentially selecting the signal of the path A and the signal of the path B.

When the signal of the path A and the signal of the path B are switched by equal time allocation, update of the distortion compensation coefficient is not performed sufficiently for the signal of the path A, which experiences a relatively large distortion as illustrated in a frequency spectrum at the lower portion of FIG. **7**. Consequently, sufficient distortion compensation is not performed for the signal of the path A (the rise of the side lobes is slightly decreased but remains even after distortion compensation since distortion compensation is not sufficient). On the other hand, the rise of the side lobes does not occur for the signal of the path B, which experiences nearly no distortion, since there is almost no distortion from the beginning; however update of the distortion compensation coefficient is performed frequently for the signal of the path B as well, which is actually unnecessary. As a result, time taken for compensating for distortions of the signal of the path A and the signal of the path B becomes long.

Next, a flowchart of a process performed by the wireless apparatus **200** according to the second embodiment will be described. FIG. **8** illustrates a flowchart of an exemplary process performed by the wireless apparatus **200** according to the second embodiment. As illustrated in FIG. **8**, the subtractor **172** first calculates a difference between a feedback signal and a transmission signal before distortion compensation in the path A (step S**101**). The subtractor **172** then calculates a difference between a feedback signal and a transmission signal before distortion compensation in the path B (step S**102**). The subtractor **172** then calculates a difference between a feedback signal and a transmission signal before distortion compensation in the path C (step S**103**). The subtractor **172** then calculates a difference between a feedback signal and a transmission signal before distortion compensation in the path D (step S**104**).

Subsequently, the SW controller **180** calculates selection time periods of the respective paths based on the calculated differences of the respective paths (step S**105**). For example, the SW controller **180** may calculate and allocate time periods for selecting signals of the respective paths in the switch **162** in proportion to the magnitudes of the calculated differences of the respective paths. Alternatively, the SW controller **180** may calculate time periods for selecting signals of the respective paths in the switch **162** based on the magnitudes of the calculated differences of the respective paths, but not in proportion to the magnitudes.

Subsequently, the SW controller **180** executes selection (switching) of feedback signals of the respective paths in the switch **162** in accordance with the calculated selection time periods of the respective paths (step S**106**).

[c] Third Embodiment

Next, a wireless apparatus **300** according to a third embodiment will be described. The wireless apparatus **300** of the third embodiment differs from that of the second embodiment in that adjacent channel leaking power or an ACPR of a feedback signal is used as an index of a magnitude of a distortion. Description of structural components and functions similar to those of the second embodiment will not be repeated.

FIG. **9** illustrates a configuration of the wireless apparatus **300** according to the third embodiment. As illustrated in FIG. **9**, the wireless apparatus **300** includes a Fourier transform unit (FFT (Fast Fourier Transform)) **190**, an ACPR calculator **192**, an adjacent channel leaking power calculator **194**, and an SW controller **196**.

The Fourier transform unit **190** performs fast Fourier transform processing on a feedback signal that has been selected in the switch **162** and has thereafter undergone processing in the A/D converter **168** and the modulator **170**. Based on a signal output from the Fourier transform unit **190**, the ACPR calculator **192** calculates a ratio of power of adjacent channels to power of a main channel for the signal. It is to be noted that, although an example of calculating the ACPR is illustrated in the present embodiment, an ACLR (Adjacent Channel Leakage Ratio) can be used instead of the ACPR.

The adjacent channel leaking power calculator **194** calculates adjacent channel leaking power of the feedback signal that has been selected in the switch **162** and has thereafter undergone processing in the A/D converter **168** and the modulator **170**.

The SW controller **196** controls the length of time during which each feedback signal is selected in a time-divisional manner in the switch **162** depending on the magnitude of a distortion of each of a plurality of transmission signals output from a plurality of paths A to D. For example, the SW controller **196** controls the length of time during which each feedback signal is selected in a time-divisional manner in the switch **162** depending on the ratio of power of adjacent channels to power of a main channel for each feedback signal calculated in the ACPR calculator **192**. More specifically, the SW controller **196** compares the magnitudes of the ratios of power of adjacent channels to power of a main channel for the respective feedback signals calculated in the ACPR calculator **192**. The SW controller **196** then makes the length of time during which a feedback signal is selected in a time-divisional manner in the switch **162** longer for a feedback signal from a path having a larger ratio of power of adjacent channels to power of a main channel. In other words, the SW controller **196** provides a path having a larger power ratio with a larger number of times of updating of the distortion compensation coefficient stored in the distortion compensation coefficient storing unit **114** (LUT).

For example, the SW controller **196** controls the length of time during which each feedback signal is selected in a time-divisional manner in the switch **162** depending on the magnitude of the adjacent channel leaking power of each feedback signal calculated in the adjacent channel leaking power calculator **194**. More specifically, the SW controller **196** compares the adjacent channel leaking power values of the respective feedback signals calculated in the adjacent channel leaking power calculator **194**. The SW controller **196** then makes a time during which a feedback signal is selected in a time-divisional manner in the switch **162** longer for a feedback signal from a path having a larger adjacent channel leaking power value. In other words, the SW controller **196** provides a path having a larger adjacent channel leaking power value with a larger number of times of updating of the distortion compensation coefficient stored in the distortion compensation coefficient storing unit **114** (LUT).

Next, a flowchart of an exemplary process performed by the wireless apparatus **300** according to the third embodiment will be described. FIG. **10** illustrates a flowchart of an exemplary process performed by the wireless apparatus **300** according to the third embodiment. As illustrated in FIG. **10**, the Fourier transform unit **190** first performs fast Fourier transform on a feedback signal in the path A (step S**201**). Subsequently, the ACPR calculator **192** calculates a ratio of power of adjacent channels to power of a main channel for the feedback signal in the path A (step S**202**).

Subsequently, the Fourier transform unit **190** performs fast Fourier transform on a feedback signal in the path B (step S**203**). Subsequently, the ACPR calculator **192** calculates a

ratio of power of adjacent channels to power of a main channel for the feedback signal in the path B (step S**204**).

Subsequently, the Fourier transform unit **190** performs fast Fourier transform on a feedback signal in the path C (step S**205**). Subsequently, the ACPR calculator **192** calculates a ratio of power of adjacent channels to power of a main channel for the feedback signal in the path C (step S**206**).

Subsequently, the Fourier transform unit **190** performs fast Fourier transform on a feedback signal in the path D (step S**207**). Subsequently, the ACPR calculator **192** calculates a ratio of power of adjacent channels to power of a main channel for the feedback signal in the path D (step S**208**).

Subsequently, the SW controller **196** calculates selection time periods of the respective paths based on the calculated power ratios of the respective paths (step S**209**). For example, the SW controller **196** may calculate time periods for selecting the respective paths in the switch **162** in proportion to the magnitudes of the calculated power ratios of the respective paths. Alternatively, the SW controller **196** may calculate time periods for selecting the respective paths in the switch **162** in accordance with the magnitudes of the calculated power ratios of the respective paths but not in proportion to the magnitudes.

Subsequently, the SW controller **196** executes selection (switching) of feedback signals of the respective paths in the switch **162** in accordance with the calculated selection time periods of the respective paths (step S**210**).

Next, a flowchart of another exemplary process performed by the wireless apparatus **300** according to the third embodiment will be described. FIG. **11** illustrates a flowchart of another exemplary process performed by the wireless apparatus **300** according to the third embodiment. As illustrated in FIG. **11**, the Fourier transform unit **190** first performs fast Fourier transform on a feedback signal in the path A (step S**301**). Subsequently, the adjacent channel leaking power calculator **194** calculates adjacent channel leaking power for the feedback signal in the path A (step S**302**).

Subsequently, the Fourier transform unit **190** performs fast Fourier transform on a feedback signal in the path B (step S**303**). Subsequently, the adjacent channel leaking power calculator **194** calculates adjacent channel leaking power for the feedback signal in the path B (step S**304**).

Subsequently, the Fourier transform unit **190** performs fast Fourier transform on a feedback signal in the path C (step S**305**). Subsequently, the adjacent channel leaking power calculator **194** calculates adjacent channel leaking power for the feedback signal in the path C (step S**306**).

Subsequently, the Fourier transform unit **190** performs fast Fourier transform on a feedback signal in the path D (step S**307**). Subsequently, the adjacent channel leaking power calculator **194** calculates adjacent channel leaking power for the feedback signal in the path D (step S**308**).

Subsequently, the SW controller **196** calculates selection time periods of the respective paths based on the calculated adjacent channel leaking power values of the respective paths (step S**309**). For example, the SW controller **196** may calculate time periods for selecting the respective paths in the switch **162** in proportion to the magnitudes of the calculated adjacent channel leaking power values of the respective paths. Alternatively, the SW controller **196** may calculate time periods for selecting signals of the respective paths in the switch **162** in accordance with the magnitudes of the calculated adjacent channel leaking power values of the respective paths, but not in proportion to the magnitudes.

Subsequently, the SW controller **196** executes selection (switching) of feedback signals of the respective paths in the switch **162** in accordance with the calculated selection time periods of the respective paths (step S**310**).

As described above, the wireless apparatuses according to the embodiments include a plurality of amplifiers, monitor magnitudes of distortions of signals output from the respective amplifiers, and control the switching time periods of feedback signals in accordance with the magnitudes. For example, the wireless apparatus **200** controls the switch **162** so that update in the LUT may be performed for a longer time period for a path including an amplifier having a large distortion than for a path including an amplifier having a small distortion. As a result, sufficient distortion compensation is performed for the path experiencing a large distortion. On the other hand, update of the distortion compensation coefficient is not performed frequently for the signal of the path having a small distortion. Because the signal of such path experiences almost no distortion from the beginning, an influence on adjacent channels is restricted. Thus, according to the wireless apparatuses of the embodiments, it is possible to shorten the time for distortion compensation in the apparatus as a whole.

According to an embodiment, time taken for distortion compensation of signals output from a plurality of amplifiers can be shortened.

Further, the process performed by the wireless apparatus according to an embodiment may be stored, as a computer program, in a computer-readable storage medium such as floppy disk, CD-ROM (compact disc read only memory), DVD (digital versatile disc), magnet-optical disc and IC card. The program may be read from the computer-readable storage medium and executed by a computer.

All examples and conditional language recited herein are intended for pedagogical purposes of aiding the reader in understanding the invention and the concepts contributed by the inventor to further the art, and are not to be construed as limitations to such specifically recited examples and conditions, nor does the organization of such examples in the specification relate to a showing of the superiority and inferiority of the invention. Although the embodiments of the present invention have been described in detail, it should be understood that the various changes, substitutions, and alterations could be made hereto without departing from the spirit and scope of the invention.

What is claimed is:

1. A wireless apparatus comprising:

a plurality of amplifying systems each including:

a storing unit that stores a distortion compensation coefficient for use in compensation for a nonlinear distortion of one or more transmission signals;

a compensator that compensates for the nonlinear distortion of the transmission signal with use of the distortion compensation coefficient stored in the storing unit; and

an amplifier that amplifies the transmission signal subjected to the distortion compensation in the compensator;

a switch that selects a plurality of feedback signals corresponding to the plurality of transmission signals output from the plurality of amplifying systems sequentially in a time-divisional manner;

a subtractor that derives one or more differences between the feedback signal selected in the switch and the transmission signal, corresponding to the feedback signal, before the distortion compensation in the compensator;

a first calculator that derives a distortion compensation coefficient that restricts the difference derived in the subtractor and updates the distortion compensation

coefficient stored in the storing unit in the corresponding amplifying system by the derived distortion compensation coefficient; and

a switch controller that controls the length of time during which each of the feedback signals is selected in the time-divisional manner in the switch depending on a magnitude of the distortion of each of the plurality of transmission signals output from the plurality of amplifying systems, the switch controller comparing the plurality of differences corresponding to the plurality of feedback signals derived in the subtractor with one another and causing the length of time during which the feedback signal is selected in the time-divisional manner to be longer for the feedback signal from the amplifying system having the larger difference.

2. A wireless apparatus comprising:

a plurality of amplifying systems each including:

a storing unit that stores a distortion compensation coefficient for use in compensation for a nonlinear distortion of one or more transmission signals;

a compensator that compensates for the nonlinear distortion of the transmission signal with use of the distortion compensation coefficient stored in the storing unit; and

an amplifier that amplifies the transmission signal subjected to the distortion compensation in the compensator;

a switch that selects a plurality of feedback signals corresponding to the plurality of transmission signals output from the plurality of amplifying systems sequentially in a time-divisional manner;

a subtractor that derives one or more differences between the feedback signal selected in the switch and the transmission signal, corresponding to the feedback signal, before the distortion compensation in the compensator;

a first calculator that derives a distortion compensation coefficient that restricts the difference derived in the subtractor and updates the distortion compensation coefficient stored in the storing unit in the corresponding amplifying system by the derived distortion compensation coefficient;

a second calculator that calculates adjacent channel leaking power values of the respective feedback signals based on the plurality of feedback signals; and

a switch controller that controls the length of time during which each of the feedback signals is selected in the time-divisional manner in the switch depending on a magnitude of the distortion of each of the plurality of transmission signals output from the plurality of amplifying systems, the switch controller also controls the length of time during which each of the feedback signals is selected in the time-divisional manner depending on a magnitude of the adjacent channel leaking power values of each of the feedback signals calculated in the second calculator.

3. The wireless apparatus according to claim **2**, wherein the switch controller compares the adjacent channel leaking power values of the respective feedback signals calculated in the second calculator and causes the length of time during which the feedback signal is selected in the time-divisional manner in the switch to be longer for the feedback signal from the amplifying system having the larger adjacent channel leaking power value.

4. A wireless apparatus comprising:

a plurality of amplifying systems each including:

a storing unit that stores a distortion compensation coefficient for use in compensation for a nonlinear distortion of one or more transmission signals;

a compensator that compensates for the nonlinear distortion of the transmission signal with use of the distortion compensation coefficient stored in the storing unit; and

an amplifier that amplifies the transmission signal subjected to the distortion compensation in the compensator;

a switch that selects a plurality of feedback signals corresponding to the plurality of transmission signals output from the plurality of amplifying systems sequentially in a time-divisional manner;

a subtractor that derives one or more differences between the feedback signal selected in the switch and the transmission signal, corresponding to the feedback signal, before the distortion compensation in the compensator;

a first calculator that derives a distortion compensation coefficient that restricts the difference derived in the subtractor and updates the distortion compensation coefficient stored in the storing unit in the corresponding amplifying system by the derived distortion compensation coefficient;

a third calculator that calculates ratios of power of adjacent channels to power of a main channel for the respective feedback signals based on the plurality of feedback signals; and

a switch controller that controls the length of time during which each of the feedback signals is selected in the time-divisional manner in the switch depending on a magnitude of the distortion of each of the plurality of transmission signals output from the plurality of amplifying systems, the switch controller also controls the length of time during which each of the feedback signals is selected in the time-divisional manner depending on the ratios calculated in the third calculator.

5. The wireless apparatus according to claim **4**, wherein the switch controller compares magnitudes of the ratios of the power of the adjacent channels to the power of the main channel for the respective feedback signals calculated in the third calculator and causes the length of time during which the feedback signal is selected in the time-divisional manner in the switch to be longer for the feedback signal from the amplifying system having the larger ratio of the power of the adjacent channels to the power of the main channel.

6. A distortion compensating method comprising:

(a) executing in each of a plurality of amplifying systems:

(a1) reading a distortion compensation coefficient from a storing unit that stores the distortion compensation coefficient for use in compensation for a nonlinear distortion of one or more transmission signals and compensating for the nonlinear distortion of the transmission signal with use of the read distortion compensation coefficient; and

(a2) amplifying the transmission signal subjected to the distortion compensation;

(b) selecting a plurality of feedback signals corresponding to the plurality of transmission signals output from the plurality of amplifying systems sequentially in a time-divisional manner;

(c) deriving a difference between the selected feedback signal and the transmission signal, corresponding to the feedback signal, before the distortion compensation;

(d) deriving a distortion compensation coefficient that restricts the derived difference and updating the storing

unit in the corresponding amplifying system by the derived distortion compensation coefficient; and

(e) controlling the length of time during which each of the feedback signals is selected in the time-divisional manner depending on a magnitude of the distortion of each of the plurality of transmission signals output from the plurality of amplifying systems, by comparing a plurality of differences derived in the (c) deriving and corresponding to the plurality of feedback signals selected in the (b) selecting with one another and causing the length of time during which the feedback signal is selected in the time-divisional manner to be longer for the feedback signal from the amplifying system having the larger difference.

7. A distortion compensating method comprising:

(a) executing in each of a plurality of amplifying systems:

(a1) reading a distortion compensation coefficient from a storing unit that stores the distortion compensation coefficient for use in compensation for a nonlinear distortion of one or more transmission signals and compensating for the nonlinear distortion of the transmission signal with use of the read distortion compensation coefficient; and

(a2) amplifying the transmission signal subjected to the distortion compensation;

(b) selecting a plurality of feedback signals corresponding to the plurality of transmission signals output from the plurality of amplifying systems sequentially in a time-divisional manner;

(c) deriving a difference between the selected feedback signal and the transmission signal, corresponding to the feedback signal, before the distortion compensation;

(d) deriving a distortion compensation coefficient that restricts the derived difference and updating the storing unit in the corresponding amplifying system by the derived distortion compensation coefficient;

(e) calculating adjacent channel leaking power values of the respective feedback signals based on the plurality of feedback signals; and

(f) controlling the length of time during which each of the feedback signals is selected in the time-divisional manner depending on a magnitude of the distortion of each of the plurality of transmission signals output from the plurality of amplifying systems, and also controlling the length of time during which each of the feedback signals is selected in the time-divisional manner depending on a magnitude of the adjacent channel leaking power values of each of the feedback signals calculated in the (e) calculating.

8. The distortion compensating method according to claim **7**, wherein the (f) controlling controls the length of time by comparing the adjacent channel leaking power values of the respective feedback signals calculated in the (e) calculating and causing the length of time during which the feedback signal is selected in the time-divisional manner to be longer for the feedback signal from the amplifying system having the larger adjacent channel leaking power value.

9. A distortion compensating method comprising:

(a) executing in each of a plurality of amplifying systems:

(a1) reading a distortion compensation coefficient from a storing unit that stores the distortion compensation coefficient for use in compensation for a nonlinear distortion of one or more transmission signals and compensating for the nonlinear distortion of the transmission signal with use of the read distortion compensation coefficient; and

(a2) amplifying the transmission signal subjected to the distortion compensation;

(b) selecting a plurality of feedback signals corresponding to the plurality of transmission signals output from the plurality of amplifying systems sequentially in a time-divisional manner;

(c) deriving a difference between the selected feedback signal and the transmission signal, corresponding to the feedback signal, before the distortion compensation;

(d) deriving a distortion compensation coefficient that restricts the derived difference and updating the storing unit in the corresponding amplifying system by the derived distortion compensation coefficient;

(e) calculating ratios of power of adjacent channels to power of a main channel for the respective feedback signals based on the plurality of feedback signals; and

(f) controlling the length of time during which each of the feedback signals is selected in the time-divisional manner depending on a magnitude of the distortion of each of the plurality of transmission signals output from the plurality of amplifying systems, and also controlling the length of time during which each of the feedback signals is selected in the time-divisional manner depending on the ratios calculated in the (e) calculating.

10. The distortion compensating method according to claim **9**, wherein the (f) controlling controls the length of time by comparing magnitudes of the ratios of the power of the adjacent channels to the power of the main channel for the respective feedback signals calculated in the (e) calculating and causing the length of time to be longer for the feedback signal from the amplifying system having the larger ratio of the power of the adjacent channels to the power of the main channel.

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